Computational Structures in Data Science

UC Berkeley EECS
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Lambdas
Environments
Dictionaries

Computing In the News: Online Privacy, NYT 2/7/2023

Americans Flunked Test on Online Privacy

Natasha Singer; Jason Karaian

Researchers at the University of Pennsylvania (UPenn), the University of New Hampshire, and Northeastern University analyzing the results of a poll of more than 2,000 American adults found most could not pass a test about online privacy. Few respondents said they trusted how online services managed their personal data, while many seemed unaware of the limitations of federal safeguards for online data collection. The report adds to a growing body of research suggesting the notice-and-consent framework that has long served as the basis for online privacy regulation in the U.S. has become obsolete. “The big takeaway here is that consent is broken, totally broken,” said UPenn’s Joseph Turow.

Report Link

Announcements

- Reminder: Check Ed for links/forms for Extensions and switching for CS61A

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Lambda Expressions

Learning Objectives

- Lambda are anonymous functions, which use expressions
  - Don’t use `return`, lambdas always return the value of the expression.
  - They are typically short and concise
  - They don’t have an “intrinsic” name when using an environment diagram.
    - Their name is the character λ

Why Use Lambdas?

- We often can use the behavior of simple function!
- Using functions gives us flexibility

lambda

- Function expression
  - "anonymous" function creation
  - Expression, not a statement, no return or any other statement

lambda <arg or arg_tuple> : <expression using args>

```
add_one = lambda v : v + 1
```

```
def add_one(v):
    return v + 1
```

Lambdas

```
>>> def make_adder(i):
...     return lambda x: x+i
...
>>> make_adder(3)
<function make_adder.<locals>.<lambda> at 0x10073c510>

>>> make_adder(3)(4)
7

>>> list(map(make_adder(3), [1,2,3,4]))
[4, 5, 6, 7]
>>>
```

Lambda with HOFs

- **A function that returns (makes) a function**

```
def leq_maker(c):
    return lambda val: val <= c
```

```
>>> leq_maker(3)
<function leq_maker.<locals>.<lambda> at 0x1019d8c80>

>>> leq_maker(3)(4)
False

>>> filter(leq_maker(3), [0,1,2,3,4,5,6,7])
[0, 1, 2, 3]
```

Sorting Data

- It is often useful to sort data.
- What property should we sort on?
  - Numbers: We can clearly sort.
  - What about the length of a word?
  - Alphabetically?
  - What about sorting a complex data set, but 1 attribute?
    - » Image I have a list of courses: I could sort be course name, number of units, start time, etc.
- Python provides 1 function which allows us to provide a *lambda* to control its behavior

Lambda Examples

```
>>> sorted([1,2,3,4,5], key = lambda x: x)
    [1, 2, 3, 4, 5]

>>> sorted([1,2,3,4,5], key = lambda x: -x)
    [5, 4, 3, 2, 1]

# Nonsensical pairing of numbers and words…
>>> sorted([(2, "hi"), (1, "how"), (5, "goes"), (7, "it")],
           key = lambda x:x[0])
[(1, 'how'), (2, 'hi'), (5, 'goes'), (7, 'it')]

>>> sorted([(2, "hi"), (1, "how"), (5, "goes"), (7, "it")],
          key = lambda x:x[1])
    [(7, 'it'), (5, 'goes'), (2, 'hi'), (1, 'how')]

>>> sorted([(2,"hi"),(1,"how"),(5,"goes"),(7,"it")],
          key = lambda x: len(x[1]))
    [(7, 'it'), (2, 'hi'), (1, 'how'), (5, 'goes')]
```

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Environment Diagrams

Revisiting Environments

```
def make_adder(n):
    return lambda k: k + n

add_2 = make_adder(2)
add_3 = make_adder(3)
x = add_2(5)
y = add_3(x)
```

Revisiting Environments: compose w/lambda

```
def make_adder(n):
    return lambda k: k + n
def compose(f, g):
    return lambda x: f(g(x))

add_2 = make_adder(2)
add_3 = make_adder(3)
add_5 = compose(add_2, add_3)

x = add_2(2)
z = add_5(x)
```

Environment Diagrams

- Organizational tools that help you understand code
- **Terminology:**
  - **Frame:** keeps track of variable-to-value bindings, each function call has a frame
  - **Global Frame:** global for short, the starting frame of all python programs, doesn't correspond to a specific function
  - **Parent Frame:** The frame of where a function is defined (default parent frame is global)
  - **Frame number:** What we use to keep track of frames, f1, f2, f3, etc
  - **Variable** vs **Value**: x = 1. x is the **variable**, 1 is the **value**

Environment Diagrams Reminders

1. Always draw the global frame first
2. When evaluating assignments (lines with single equal), always evaluate right side first
3. When you CALL a function MAKE A NEW FRAME!
4. When assigning a primitive expression (number, boolean, string) write the value in the box
5. When assigning anything else (lists, functions, etc.), draw an arrow to the value
6. When calling a function, name the frame with the intrinsic name – the name of the function that variable points to
7. The parent frame of a function is the frame in which it was defined in (default parent frame is global)
8. If the value for a variable doesn't exist in the current frame, search in the parent frame

Demo

Example 1:

- make_adder Higher Order Function: Environment Diagram Python Tutor Link

Example 2:

- Compose Python Tutor Link

Environment Diagram Tips / Links

- NEVER draw an arrow from one variable to another.
- Useful Resources:
  - http://markmiyashita.com/cs61a/environment_diagrams/rules_of_environment_diagrams/
  - http://albertwu.org/cs61a/notes/environments.html

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Dictionaries

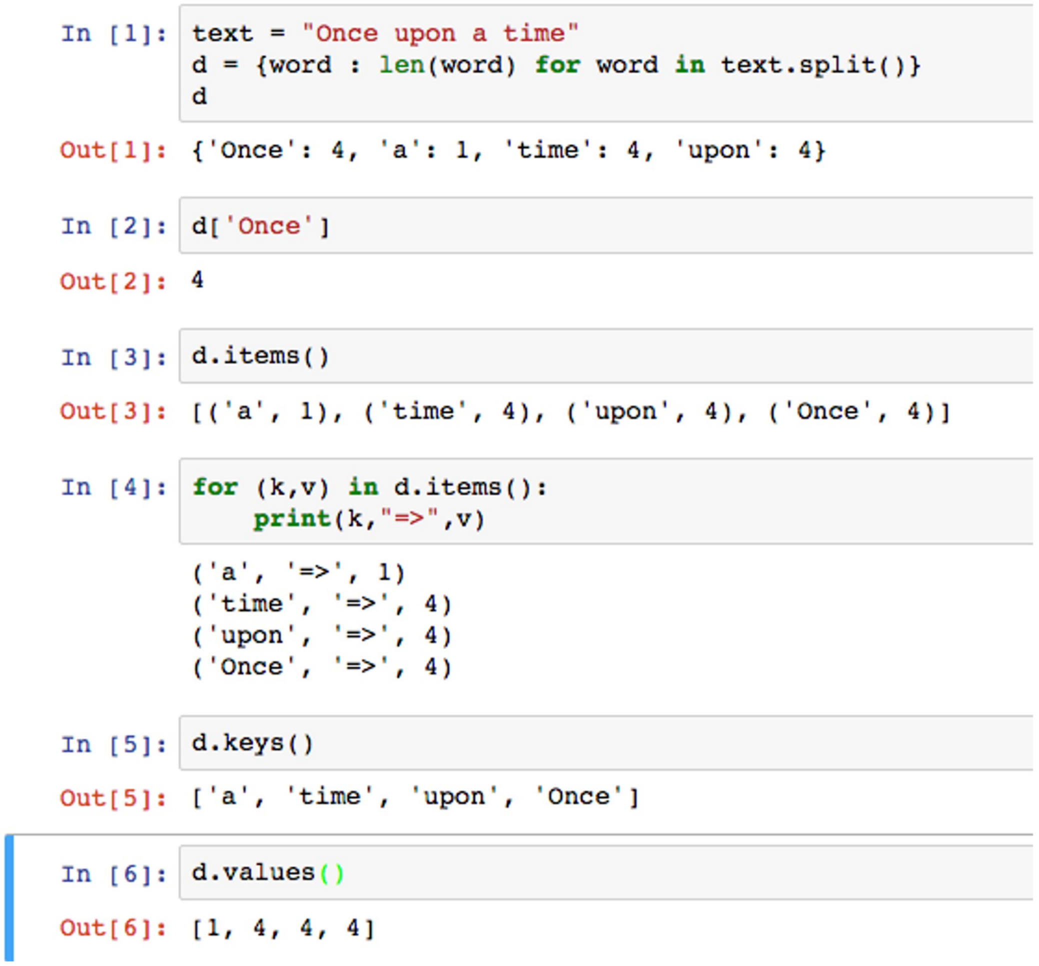
Learning Objectives

- Dictionaries are a new type in Python
- Lists let us index a value by a number, or position.
- Dictionaries let us index data by other kinds of data.

Dictionaries

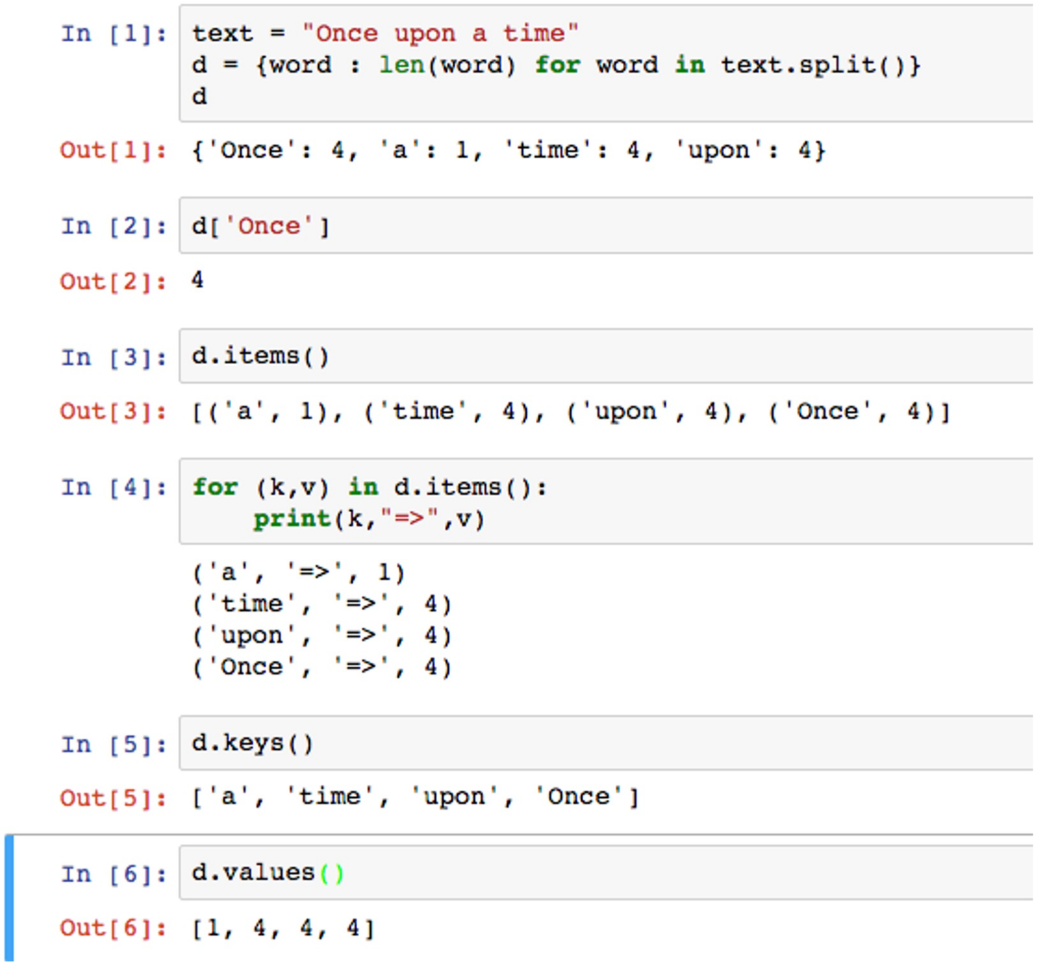
- Constructors:
  - » `dict( <list of 2-tuples> )`
  - » `dict( <key>=<val>, ...) # like kwargs`
  - » **`{ <key exp>:<val exp>, …  }`**
  - » `{ <key>:<val> for <iteration expression> }`
    - `>>> {x:y for x,y in zip(["a","b"],[1,2])}`
    - `{'a': 1, 'b': 2}`
- Selectors: **`<dict>[ <key> ]`**
  - » <dict>.keys(), .items(), .values()
  - » <dict>.get(key [, default])
- Operations:
  - » Key in, not in, len, min, max
  - » <dict>[<key>] = <val>

Dictionary Example



```
In [1]: text = "Once upon a time"
        d = {word : len(word) for word in text.split()}
        d

Out[1]: {'Once': 4, 'a': 1, 'time': 4, 'upon': 4}

In [2]: d['Once']

Out[2]: 4

In [3]: d.items()

Out[3]: [('a', 1), ('time', 4), ('upon', 4), ('Once', 4)]

In [4]: for (k,v) in d.items():
            print(k,"=>",v)

        ('a', '=>', 1)
        ('time', '=>', 4)
        ('upon', '=>', 4)
        ('Once', '=>', 4)

In [5]: d.keys()

Out[5]: ['a', 'time', 'upon', 'Once']

In [6]: d.values()

Out[6]: [1, 4, 4, 4]
```

Dictionary Example



```
In [1]: text = "Once upon a time"
        d = {word : len(word) for word in text.split()}
        d

Out[1]: {'Once': 4, 'a': 1, 'time': 4, 'upon': 4}

In [2]: d['Once']

Out[2]: 4

In [3]: d.items()

Out[3]: [('a', 1), ('time', 4), ('upon', 4), ('Once', 4)]

In [4]: for (k,v) in d.items():
            print(k,"=>",v)

        ('a', '=>', 1)
        ('time', '=>', 4)
        ('upon', '=>', 4)
        ('Once', '=>', 4)

In [5]: d.keys()

Out[5]: ['a', 'time', 'upon', 'Once']

In [6]: d.values()

Out[6]: [1, 4, 4, 4]
```